7 SRP SYSTEM ADJUSTMENTS

7.1 Adjustments of SRP Pressure Measurement

SRP Program: **Scaler Test**
Equipment: **Small (Jeweler's) Screwdriver**
Specification: **Zero (700.0 ± 0.1 mbar),**
Span (Atm. Lab Pressure Standard Value ± 0.2 mbar)
See Figure(s):

The measurement of pressure is done using a Setra Model 270 pressure transducer which has a pressure measurement range of 700 to 1100 millibar (mbar) and an output signal of 0 to 5 V. This voltage signal then enters the SRP electronics where it is proportionally scaled then converted to a frequency. The corresponding frequency is counted in the SRPs 5 second counting cycle producing a final pressure value. Adjustments to the Setra pressure transducer are only to be done by Setra. Therefore, the only pressure measurement adjustments that need to be made are the SRP Circuits Pressure ZERO and SPAN. *The difficulty with this procedure is that adjustments made to the SRP Circuits Pressure Zero affect the SRP Circuits Pressure Span and likewise, adjustments made to the SRP Circuits Pressure Span affect the SRP Circuits Pressure Zero. For this reason it is often necessary to go back and forth from each measurement/adjustment for several iterations until both are set to the correct value.*

7.1.1 SRP Pressure Zero (700.0 ± 0.1 mbar)

The SRP electronics module has two sets of ZERO and SPAN adjustment potentiometers mounted on the front panel. The upper set for Temperature, and the lower set for Pressure. Clockwise rotation will increase the values, and counter clockwise will decrease the values. Additionally, there are two sets of RUN/CAL switches, and red (POSITIVE) test points. A common black (NEGITIVE) test point is used for both temperature and pressure. *The RUN/CAL switch can be changed at any time regardless of the operation mode of the SRP. Also, voltage measurements can be made at the test points at any time.*

To check/adjust the SRP Pressure Zero:

- Run the "Scaler Test" program (See Program Control Section) which will update the SRP scalers every 5 seconds continuously.
- Place the RUN/CAL switch to CAL and observe the pressure value readings on the front panel of the SRP electronics module.
- Adjust the pressure zero potentiometer until the pressure value reads 700.0 ± 0.1 mbar.

7.1.2 SRP Pressure Span (Atm. Lab Pressure Standard Reading ± 0.2 mbar)

To check/adjust the SRP Pressure Span:

Make sure the SRP sample pump is off, and no pressure build up is occurring due to airflow from any air source. The SRP should be measuring atmospheric pressure to be compared with your atmospheric lab pressure standard.

- Run the "scaler test" program (See Program Control Section) which will update the SRP scalers every 5 seconds continuously.
- Place the RUN/CAL switch to RUN and observe the pressure value readings on the front panel of the SRP electronics module front panel.
- Adjust the pressure zero potentiometer until the pressure value reads (Atmospheric Lab Pressure Standard reading) ± 0.1 mbar.

If an adjustment was made it will now be necessary to go back and check the SRP Pressure Zero again. Continue back and forth from the SRP Pressure Zero and Span until both values are set within their limits. This procedure can initially be lengthy and troublesome, but with practice will be improved.

7.2 Adjustments of SRP Temperature Measurement

SRP Program: Scaler Test
Equipment: Small (Jeweler's) Screwdriver, Digital Voltmeter, STOLAB Temperature Calibrator
Specification: STOLAB Circuit Card Zero (0.20 mV ± 0.10 mV)
STOLAB Circuit Card Span (300.0 ± 0.1 mV, or 1000.0 ± 0.1 mV)
SRP Circuits Zero (0.20 mV ± 0.10 mV)
SRP Circuits Span (30.000 ± 0.010 ° C or 100.000 ±0.010 ° C)
See Figure(s):

The measurement of temperature is done using a Stow Laboratories (STOLAB) Model PL-103 temperature sensor and a STOLAB Model 954 PL-C circuit card, which produces a voltage signal corresponding to a specific temperature. The voltage range of 0.0 mV to 1000.0 mV is equal to a temperature range of 0.0°C to 100.0°C (10 mV/°C). This voltage signal then enters the SRP electronics where it is proportionally scaled then converted to a frequency. The corresponding frequency is counted in the SRPs 5 second counting cycle producing a final temperature value. Therefore, the temperature measurement adjustment procedures are done in two separate steps (A) STOLAB Circuit Card, and (B) SRP Circuits.

Calibration of both circuits can be done using a STOLAB temperature calibrator that provides two fixed temperature points. The standard STOLAB PL-100 C calibrator covers the full range of the STOLAB circuit card with a 0.0° C, and a 100.0° C calibration point. A special order STOLAB PL-0/30 C calibrator can also be used with 0.0° C, and 30.0° C calibration points. Since the SRP is normally not operated above 30.0° C, the special order calibrator was provided for use with the SRP, but it has been demonstrated that there is no advantage to using it. Either type of STOLAB calibrator can be sent back to STOLAB for a calibration check on some regular interval.

Additionally, calibration of the STOLAB circuit card and the SRP circuits can be performed by immersing the SRP's STOLAB Model PL-103 temperature sensor into a temperature bath of known temperatures measured by a certified temperature measurement device.

7.2.1 STOLAB Circuit Card Zero (0.0 ± 0.1 mV)

The STOLAB Circuit Card plugs into the SRP main interface and timing generation board (SRP main board) inside the SRP electronics module. It has ZERO and SPAN adjustment potentiometers mounted on it facing upward inside the SRP electronics module. These potentiometers are easily accessible once the top lid of the SRP electronics module is slid back. Clockwise rotation will increase the values, and counter clockwise will decrease the values. The measurement of the STOLAB voltage signal is done on the SRP main board at test points (TP 2) (positive), and TP 14 (analog ground). There are additional analog ground test points on the SRP main board that can also be used for the ground connection.

To check/adjust the STOLAB Circuit Card Zero using the STOLAB calibrator:

- Locate STOLAB temperature sensor socket on the rear panel of the SRP electronics module. Remove STOLAB temperature sensor and replace with STOLAB calibrator. Allow 15 minutes for STOLAB calibrator to stabilize. Place STOLAB calibrator switch on 0.0° C.
- Slide SRP electronics module top lid back until STOLAB circuit card is accessible.

Remember that once the SRP electronics module lid is opened the temperature inside may be affected which can affect the operation of the electronics inside. For this reason it is suggested to make measurements and adjustments as quickly as possible to minimize temperature drift effects of electronic components inside the SRP electronics module.

- Using a suitable voltage measurement device (DVM) on a mV range, measure the voltage across TP2 and TP14 then adjust the STOLAB Circuit Card Zero potentiometer until the voltage reading is 0.0 and 0.1 mV. This is typically easily done to a tenth of a millivolt or better.

7.2.2 STOLAB Circuit Card Span (300.0 ± 0.1 mV, or 1000.0 ± 0.1 mV)

To check/adjust the STOLAB Circuit Card Span using the STOLAB calibrator:

- Place the STOLAB calibrator switch to either the 30° C, for the 100° C position depending on which calibrator you are using.
- Now measure the voltage across TP2 and TP14 and adjust the STOLAB Circuit Card Span potentiometer to obtain desired value. For the 30° C calibrator the voltage reading should be 300.0 ± 0.1 mV, and for the 100° C calibrator the reading should be 1000.0 ± 0.1 mV.

Remember that the DVM must be set on an appropriate range for the measured value.

- If an adjustment was made to the STOLAB Circuit Card span, it may be desirable to go back to the 0°C calibrator switch setting and check that the STOLAB Circuit Card Zero has not changed.
- Once this has been completed remove the DVM connections and slide SRP electronics module lid completely back on. The STOLAB circuit card is now calibrated.

7.2.3 SRP Circuit Zero (between 0.1 to 1.0 mV)

As mentioned previously, the SRP electronics module has two sets of Zero and Span adjustment potentiometers mounted on the front panel. Clockwise rotation will increase the values, and counter clockwise will decrease the values. The upper set for Temperature, and the lower set for Pressure. Additionally, there are two sets of RUN/CAL switches, and red (POSITIVE) test points. A common black (NEGITIVE) test point is used for both temperature and pressure. *The RUN/CAL switch can be changed at any time regardless of the operation mode of the SRP. Also, voltage measurements can be made at the test points at any time.*

To check/adjust the SRP Circuits Zero:

- Place the temperature RUN/CAL switch to CAL and measure the voltage across the red temperature (+), and the common black (-) test points using a millivolt range.
- The voltage should be set to a value between 0.1 – 1.0 mV. Under most conditions, this value should not change once set properly.

The SRP electronic zero is a voltage setting and should not be confused with a value read from the SRP electronics module front panel temperature display. A common mistake is to set the STOLAB calibrator to the 0° C position and adjust the SRP circuit zero until the front panel display reads 00.000

7.2.4 SRP Circuits Span (30.000 ± 0.010 ° C or 100.000 ±0.010 ° C)

To check/adjust the SRP Circuits Span:

- Place the STOLAB calibrator switch to the 30° C, or 100° C depending on which is being used. Remember to make sure the STOLAB calibrator is warmed up.
- Run the “Scaler Test” program (See SRP Program Control Section) so the SRP continuously updates the scalers every 5 seconds.
- Adjust the SRP temperature span potentiometer until the SRP electronics module front panel display reads 30.0 ± 0.1, or 100.0 ± 0.1 depending on which STOLAB calibrator you are using.

The front panel display provides 3 decimal places, but the real temperature is only known to 1 decimal place.

7.3 Adjustment of SRP UV Source Lamp Alignment

SRP Control Program: **Scaler Test**
Equipment and/or Tools: **Small Screwdriver, or Allen (Hex) Wrench**
Frequency Counter
Specification: **Source Lamp (adjust to maximum intensity)**
See Figure(s):

There are several manufacturers of UV source lamps that are adequate to be used in the SRP. There are also two known types of lamps that can be used in the SRP. The first is the Vycor shielded lamp, and the second is the O_3 free quartz lamp. Both lamps block out lower wavelength UV radiation that produces O_3. It is suggested to note which type and manufacturer's lamp is installed in the SRP. Either type of lamp will be manufactured with a U tube shape with electrode on either end. This design produces light of higher intensities on two opposite sides, and lower intensities on the two other opposite sides. Adjustment of the SRP UV source lamp is done to allow light of the highest intensity to enter the optical systems of the SRP.

Whether a new UV source lamp has been installed, or a currently installed UV source lamp is being re-adjusted, the procedure is the same.

The SRP UV source lamp is mounted inside the UV source lamp block and is held in place with a setscrew. The setscrew is normally made of nylon and can be either a straight screwdriver slotted, or Allen (hex) socket type. The lamp alignment is adjusted by rotating the lamp and/or by positioning the lamp further in or out of its socket to obtain the maximum signal output. The measurement of the signal output can be done by simply running the "Scaler Test" program and monitoring the scaler counts, or by use of a frequency counter to measure the frequency of the detector signal from either channel.

7.3.1 Alignment procedure using the Scaler Test program:

Run the "scaler test" program (See SRP Program Control Section) so the SRP scaler count values are updating every 5 seconds. While watching the scaler count values, carefully loosen the setscrew while holding the end of the UV lamp body. *Note: the UV lamp body will be hot*. Rotate the UV lamp and/or pull out or push in as necessary to obtain the highest scaler count value in the scaler 2 channel. Once the highest available count value is obtained, lock the lamp back in place tightly with the setscrew. *While the scaler 1 channel can be used, the scaler 2 channel is recommended because it is always a lower value and should be maximized. Because the program only updates the scaler channel count values every 5 seconds, this process may be slow.*

7.3.2 Alignment procedure using a frequency counter:

- Remove the scaler 2 output cable from the Lemo connector. This can be done at any time without damaging the system, but when a scaler cable is removed there is no signal provided to the counter circuits, so the scaler value will go to zero.

- Using the appropriate connector, connect the scaler 2 output channel to the frequency counter. The appropriate connector will depend on the input connection of the frequency counter. A Lemo to BNC connector should have been provided with the SRP. The BNC connection then can be used directly to a BNC input, or converted to another connection device. Once the frequency counter is connected properly it will provide instantaneous measurement of the output signal frequency.
- While watching the scaler frequency values, carefully loosen the set screw while holding the end of the UV lamp body. Note: the UV lamp body will be hot.
- Rotate the UV lamp and/or pull out or push in as necessary to obtain the highest scaler frequency value from the scaler 2 channel.
- Once the highest available frequency is obtained, lock the lamp back in place tightly with the set screw. In most cases, once the lamp has been locked in place, the value will change some.

7.4 Adjustment of SRP UV Source Lamp Block Temperature

SRP Control Program: None
Equipment and/or Tools: Temperature Measurement Device
Specification: Range of 45-65°C ± 0.1°C of Setting
See Figure(s):

The desired UV source lamp block temperature will vary depending on which type of lamp used, and can also depend on the stability of the lamp. The Vycor shielded lamp is typically operated between 40-55°C, where as the O_3 free quartz lamp is typically operated between 50-65°C. Each lamp has its own characteristics and may perform better at a specific operating temperature and power level. It may be desirable to test the lamp's characteristics at various temperatures and power level settings to determine the most stable operating conditions (See SRP Stability Measurement and Adjustment).

7.4.1 To adjust the UV source lamp block temperature:

NOTE: Please update with the PID controller

All of the EPA SRPs have been upgraded with two Watlow SD Series PID Temperature controllers. Before adjusting the block temperature, check to make sure that the lamp alignment is set properly and you are receiving the maximum intensity. You will need to run the stability monitor to be able to watch the changes to the Scaler Counts. To adjust the temperature simple press the up arrow button on the face of the controller to the desired setting. Watch the scaler counts, if they start to increase then keep bumping up the temperature until the scaler counts stop rising and start decreasing. Once you have found that ideal setting that will give you the maximum scaler count you will then need to Auto Tune the controller. The Auto Tune can be initiated by pressing the green key three times and the controller will read “Auto no”, Press the Up or Down key once and the display will change to “Auto on”. Press the “Infinty” key and the Auto Tune will run. The “Auto Tune’ will ramp the temperature up and down a few times during it’s cycle, so it is important to let it complete before collecting any data with the SRP. Allow about 1 hour for the cycle to complete and it may be necessary to run the :Auto Tune” more than once. Once it has successfully completed an “Auto Tune” the PID Controller will hold the

temperature set point plus or minus 0.1 degree Celsius. Details on how to program the PID Controller is set out in SRP PID Programming and Tuning.pdf attachment. For a detailed version that includes all the programming variables see the attached manual Series SD Rev F User Manual.pdf.

7.5 Adjustment of SRP UV Source Lamp Power level

SRP Control Program: Scaler Test
Equipment and/or Tools: Small (Jeweler's) Screwdriver
Specification: Scaler 2 Counts > 100,000 Counts
Scaler 1 Counts > 100,000 <250,000Counts, but will always be higher than Scaler 1 values
See Figure(s): 1

7.5.1 Adjustment of the SRP UV Source Lamp Power Level

Source Lamp Level adjustment is done by a simple adjustment to the PCI 2400 UV lamp power supply board (PCI 2400) lamp current level potentiometer. The PCI 2400 is mounted just inside the electronics module on the right side. The small potentiometer is located toward the back of the circuit card as it is mounted in the SRP electronics module. Clockwise rotation will increase the lamp current level, and counter clockwise will decrease the lamp current level.

7.6 SRP Stability Measurement and Adjustment

SRP Program: Stability Monitor
Equipment: none
Specification: Standard Deviation of Scaler 1 and 2 Counts ≤ 25.0
Standard Deviation of Ratio of S1/S2 ≤ 0.00003
See Figure(s):

Once the SRP UV Source Lamp Alignment, Block Temperature, and Power level settings have been completed it is necessary to test the stability of the lamp signal. This is done while also measuring the stability of the SRP's detector's, and counter circuitry for scaler 1, scaler 2, temperature, and pressure. The measurement of these signals is done using the "Stability Monitor" program (See SRP Control Program Section). The Stability Monitor program takes a specific number (Default=20) of 5 second count cycles, computes the average and standard deviation of the set, and repeats for a specific number of cycles (Default=10). While the average scaler count 1 and 2 values are not critical as long as they are above the minimum requirements, the standard deviation of a set of 20 scaler counts gives an indication of the stability of the UV lamp signal. Because the SRP is always making measurements based on the ratio of the counts of one scaler to the other, the most important stability measurement is the standard deviation of the ratio of the scaler 1 to scaler 2 (S1/S2). This value provides a measurement of the stability of the detectors and the counting process used in obtaining the transmittance measurement used in determining the amount of O_3 present in the absorption cells.

Commercial UV lamps used in the SRP can significantly vary in stability, but there are steps that can be taken to improve the stability of an SRP lamp. One specific thing is time. Most UV lamps are noisier when new, than after they have been "burned in" for awhile. UV lamp manufacturers do some "burn in", but it is not always enough. *Therefore, it is not uncommon for a newly installed SRP source lamp to be somewhat noisy when first installed, and improve over time*. The problem with "burning in" UV lamps is that it decreases the useable life of the lamp. The next two factors that can improve the SRP lamp stability are temperature and power setting. These two factors can be adjusted independently, or simultaneously to achieve a more stable SRP lamp signal. It may be desirable to test the SRP lamp stability at various temperature and power level settings to obtain the most stable operating conditions. A typical default setting for an O_3 free quartz lamp would be block temperature: 60.0 ± 2°C, and power level setting such that the scaler 2 counts are: 100,000 ± 2000 counts. After making these adjustments allow the system to settle down overnight, and then run the stability monitor program (See SRP Control Program Section). If the results are not acceptable then proceed with a different block temperature setting, and/or power level setting trying to obtain desirable stability results. *It may be necessary to allow the system to stabilize for a few hours, or overnight before expecting noticeable results*. See also Section 7.4.1

7.7 Adjustment of SRP Dark Count Scaler Values

SRP Control Program: Scaler Test
Equipment and/or Tools: Small (Jeweler's) Screwdriver
Specification: Between 5 and 25 counts
See Figure(s):

The adjustment of the SRP dark count scaler values (dark counts) are done to set the two detector scaler channels to baseline values. The dark counts are subtracted from the full scaler count values during an O_3 measurement. Each detector channel is independent of the other and must be adjusted separately. The dark counts are adjusted by the offset adjustment of the detector amplifiers. The signal also is converted to a frequency by a voltage to frequency (V/f) converter. *These electronic components are known to be affected by temperature and humidity. Maintaining a constant ambient temperature and humidity will greatly minimize drifting of the dark counts. It is recommended to maintain the ambient temperature to 0.2 ℃/hour drift, and keep the ambient relative humidity below 50%.*

To check/adjust the SRP dark count scaler values:

- Close the shutter on the SRP to be adjusted and run the "Scaler Test" program (See SRP Program Control Section). This will allow the scalers to be updated every five seconds, but with the source lamp signal blocked from entering the absorption cells and so the detectors do not see any light.

- Adjust the two independent potentiometers mounted on the main detector circuit board accessible through small holes on top of the detector housing. The channels are labeled 1 and 2 on the back side of the detector housing. Clockwise rotation will increase the dark count values, and counter clockwise will decrease the dark count values. ***Be careful not to turn the screwdriver when it is not properly in the potentiometer adjustment screw slot to avoid breaking the potentiometer off of the main detector circuit board.***

7.8 Adjustment of SRP Ozone Generator Block Temberature

SRP Control Program: Scaler Test or Diagnostics
Equipment and/or Tools: None
Specification: 30-45°C ± 0.1°C

The adjustment of the Temberature Block for the Ozone Generator is critical in maintaining level Ozone readings at higher concentrations. If the temperature is too low then the Ozone lamp will actually heat up the Block causing the temperature to fluctuate and adversely affection the higher level Ozone Concentrations. However, setting it too high can over –heat the MFC affecting its overall lifespan. Carefully observe the temperature of the block while generating high concentrations of Ozone. If you notice the temperature creeping up during that time you may want to restet the temperature to slightly above the highest observed temperature. Some have also found that by leaving the top open an inch or two has also been benificual in maintaining a lower steady state temperature.